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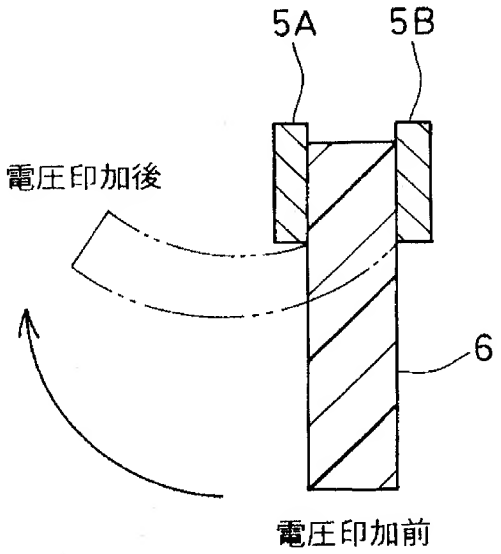
(71)出願人　591179385
平井　利博
長野県上田市諏訪形940番地の13
(72)発明者　平井　利博
長野県上田市諏訪形940番地の13
(72)発明者　渡辺　真志
長野県上田市常入１丁目15番64号
(74)代理人　100095555
弁理士　池内　寛幸　（外１名）

(54)【発明の名称】　電荷注入－溶媒牽引による駆動法及びこれを用いた駆動装置

(57)【要約】
【課題】非イオン性の誘電性溶媒または溶液に電場を印加して電荷を注入し、溶媒間、溶質間または溶媒・溶質間の相互作用に起因する溶媒流を誘起させることにより、実用レベルの駆動性を持つ、空気中での高速・大変形・大出力が可能な柔軟駆動方法を提供する。
【解決手段】ポリビニルアルコール／ジメチルスルホキシドゲル６を幅５ｍｍ、長さ７ｍｍ、厚さ１．８ｍｍに切断し横向きにセットした。ゲルの両面には金箔電極５Ａ，５Ｂを貼った。ゲルの両面上の金箔間に１０００ボルトを印加すると屈曲した。この屈曲角度は９０°で、この変形に要した時間は６０ミリ秒であった。これにより、従来の高分子ゲルの電場駆動法における欠点である応答性の遅さを改善し、10ミリ秒オーダーでの駆動を可能にすることができた。



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【特許請求の範囲】
【請求項１】　非イオン性の誘電性溶媒または溶液に電場を印加して電荷を注入することにより、溶媒間、溶質間または溶媒・溶質間の相互作用に起因する溶媒流を誘起させることを特徴とする電荷注入－溶媒牽引による駆動法。
【請求項２】　電荷を注入する手段として、櫛型電極を用いる請求項１に記載の電荷注入－溶媒牽引による駆動法。
【請求項３】　電荷を注入することにより、溶媒に圧力発生を誘起させる請求項１に記載の電荷注入－溶媒牽引による駆動法。
【請求項４】　前記誘電性溶媒または溶液に電場を印加することにより発生する圧力差を利用して、液面勾配の制御を行う電荷注入－溶媒牽引による駆動法。
【請求項５】　ゲル前駆体に前記誘電性溶媒または溶液を染み込ませて膨潤させてゲル材料を形成し、前記ゲル材料の両面に薄膜状の電極を設け、前記ゲル材料に電場を印加することにより生じる変形を用いた駆動法。
【請求項６】　前記誘電性溶媒または溶液で膨潤したゲル材料を平板上に配置された電極に接触させて生じるクローリング運動を用いた駆動法。
【請求項７】　請求項１～６のいずれかに記載の駆動法を駆動源とする駆動装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】この発明は、非イオン性の誘電性溶媒または溶液で膨潤したゲル材料の電場による駆動法及び関連材料技術に関するものである。さらに詳しくは、「電荷注入－溶媒牽引法」による高分子ゲルの高速・大変形を利用する駆動法とこれを用いた駆動装置に関するものである。
【０００２】
【従来の技術】本発明者らは各種高分子材料を用いた駆動材料・駆動法を研究開発している。電場の印加を利用した駆動法もそれに含まれている。一般にゲルの電場による駆動法は、従来法の中でも変形量と応答性で優れている。
【０００３】しかしイオン性の高分子電解質ゲルがその中心であり、非イオン性の高分子ゲルについての研究開発は本発明者らを含めて極めて少ない。
【０００４】誘電性非イオン性ゲルの電場駆動については本発明者らの提案があるのみであり、極めて優れた応答速度と変位量を誇っている（特許第2698716号公報）。
【０００５】そこでの変位は金属板によってゲルの変形が強く束縛されており、電場方向の歪みのみに限定した駆動が検討されている。
【０００６】しかしながら、柔軟体であるゲルの特性を生かした軟体動物のような駆動が期待されており、もし

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可能であれば、それがゲルの特性を最も有効に利用した駆動法である。
【０００７】従来の高分子電解質ゲルは水中、または高含水状態での駆動に限定されるため、駆動速度が遅いということ以外に、空気中などでの使用はできないという問題を持ち、さらに駆動過程で電気分解などの電気化学的な過程の介在が避けられないための不可逆的劣化という問題も含んでいた。
【０００８】
【発明が解決しようとする課題】こうした背景の中で、本発明は、駆動法に全く新規な”電荷注入”（電極からの電荷の注入）と注入された電荷の拡散過程で形成する電荷・溶媒（または溶液であるがここでは以下、溶媒と略記する）間の相互作用が誘起する”溶媒牽引”を利用した輸送系、圧力発生法を提案し、従来の問題を改良し、実用レベルの駆動性を持つ、空気中での高速・大変形・大出力が可能な柔軟駆動材料の材料設計指針、並びに駆動法を提供することを目的とする。
【０００９】
【課題を解決するための手段】前記目的を達成するため、本発明の第１番目の電荷注入－溶媒牽引による駆動法は、非イオン性の誘電性溶媒または溶液に電場を印加して電荷を注入することにより、溶媒間、溶質間または溶媒・溶質間の相互作用に起因する溶媒流を誘起させることを特徴とする。
【００１０】前記方法においては、電荷を注入する手段として、櫛型電極を用いることができる。
【００１１】また前記方法においては、電荷を注入することにより、溶媒に圧力発生を誘起させることが好ましい。
【００１２】また前記方法においては、誘電性溶媒または溶液に電場を印加することにより発生する圧力差を利用して、液面勾配の制御を行うことが好ましい。
【００１３】次に本発明の第２番目の電荷注入－溶媒牽引による駆動法は、ゲル前駆体に前記誘電性溶媒または溶液を染み込ませて膨潤させてゲル材料を形成し、前記ゲル材料の両面に薄膜状の電極を設け、前記ゲル材料に電場を印加することにより生じる変形を用いたことを特徴とする。
【００１４】前記方法においては、誘電性溶媒または溶液で膨潤したゲル材料を平板上に配置された電極に接触させて生じるクローリング運動を用いることもできる。
【００１５】次に本発明の駆動装置は、請求項１～６のいずれかに記載の駆動法を駆動源とすることを特徴とする。
【００１６】
【発明の実施の形態】本発明では以下のような技術的手段を講じている。まず、誘電性溶媒に電場を印加して単極電荷を注入すると、エミッターとなる電極（溶媒などによって決まる）から打ち出される形でコレクターとし

ての対極へ向かった流れが発生する。この注入電荷は溶媒を牽引して溶媒の流れを誘起するために、櫛形の電極を用いたポンプを作製することができる。このポンプ機能は既知の事実であるが、これにポリマーを添加することで、液体内部の空間電荷分布が顕著に変化し、その結果、驚くべきことに、極端に非対称な圧力分布が発生する。すなわち、圧力勾配が発生する。

【００１７】この溶媒で膨潤した非イオン性のゲルは上記の圧力分布をさらに非対称にする効果を持つため、極めて効果的な屈曲変形を誘起できることになる。溶液系では達成できない変形を電場によって誘起できる。

【００１８】例えば、このゲルを膜状に作製し、両面に電極を設けることで、高速で大きな屈曲変形を誘起できる。ここで、必要なことはゲル表面に電極を装着することで、そのために金箔を用いた。この電極は薄膜であるためにゲルの変形を妨害しない。

【００１９】ゲル自体に電極を持たせなくても、ゲルを電極上に置くことで、クローリング運動を誘起できる。ここでは、平板上に電極のアレイを作製しておくことが必要である。このあれ以上に、ゲルを置き、電場を印加することで極めて大きな変形を伴うクローリングがみられる。ここでも速度は極めて速い。

【００２０】

【実施例】以下、この実施例を用いて本発明をさらに具体的に説明する。

【００２１】（実施例１）市販特級のジメチルスルホキシドに櫛状の電極を用いて電場を印加することで溶媒に流動が発生した。櫛状の電極板は櫛歯間隔１㎜、櫛歯の太さ１㎜、櫛歯本数５本でアルミニウム製である。この電極を一対用意し、電極板間隔２ｍｍで直流電場を印加した。印加電圧の増加に伴い流動速度が増加した。１kVで１４ｍｍ/sの流速を得ることができる。この値は、誘電率の大きいほど、電圧の高いほど大きくなる。ほぼ全ての溶媒について観察された。

【００２２】（実施例２）図１の駆動装置１は、環状の流路を有する容器にジメチルスルホキシド３を入れ、さらに２つの櫛型電極２Ａ，２Ｂを取り付けたものである。この際、ジメチルスルホキシドの流れを見やすくするためにポリスチレンの微粒子をジメチルスルホキシド中に分散させておいた。２つの櫛形電極の間に１０００ボルトの電圧を印加すると、ジメチルスルホキシドは環状流路に沿って流動した。

【００２３】（実施例３）垂直に立った状態に置かれている電極間に挟まれた溶媒は電場の印加によって電極間に引き込まれるが、その場合の気液界面に顕著な非対称性が発生する現象を利用した圧力発生とその制御を行う。まず、幅８ｍｍ、長さ５ｃｍの２枚のアルミニウム板電極２Ａ，２Ｂを向かい合わせにして立て、その下端をシャーレに注がれたジメチルスルホキシド３の液面に浸けた。この際、２枚のアルミニウム板２Ａ，２Ｂの間隔は１．５ｍｍとした。２枚のアルミニウム板２Ａ，２Ｂの間に１０００ボルトの電圧を印加するとジメチルスルホキシド３は２枚のアルミニウム板の間を３˝のように吸い上がったが、液面は左右非対称な形になった（図２参照）。

【００２４】（実施例４）ジメチルスルホキシドの代わりに、ジメチルスルホキシドにポリビニルアルコール４（クラレ株式会社製、Ｋｒａｌａｙ　１１７、分子量＝７．５×１０４）２重量パーセントを溶解させたものを用いるほかは、実施例３と全く同様にして電圧を印加すると、４˝に示す吸い上げられた液面は左右非対称な形になった。この非対称性の度合は実施例２の場合よりずっと顕著であった（図３参照）。

【００２５】（実施例５）誘電性溶媒で膨潤した、両面に電極を有する非イオン性ゲルに直流電場を印加することで発生する、１０ミリ秒オーダーの応答速度を持つ、顕著な屈曲現象を利用する駆動法と駆動材料の具体例を以下に説明する。

【００２６】ポリビニルアルコールを１０重量％含む水溶液と、ポリビニルアルコールを１０重量％含むジメチルスルホキシド溶液とを重量比７／３の割合で混合した。その混合溶液を－２０℃で２３時間冷却し、その後、１時間室温まで昇温した。この冷却、昇温のサイクルを４回繰り返して物理架橋したポリビニルアルコールゲルを得た。次にこのゲルをグルタルアルデヒド水溶液に３℃で２日間浸漬した後、希塩酸中に３０℃で８０分浸した。これによって化学架橋されたゲルが得られた。このゲルをジメチルスルホキシド中に浸け、ゲル中の溶媒をジメチルスルホキシドに置換した。

【００２７】以上の手順で得られたポリビニルアルコール／ジメチルスルホキシドゲル６を幅５ｍｍ、長さ７ｍｍ、厚さ１．８ｍｍに切断し横向きにセットした。ゲルの両面には金箔電極５Ａ，５Ｂを貼った。ゲルの両面上の金箔間に１０００ボルトを印加すると屈曲した（図４参照）。この屈曲角度は９０°で、この変形に要した時間は６０ミリ秒であった。

【００２８】（実施例６）電極を有しない上記のゲルを平板状の電極アレイ上に置き、直流電場を印加することで生じる顕著なクローリング運動を利用する駆動法と駆動材料の具体例について以下に説明する。

【００２９】ガラス板上にアルミニウム箔７Ａ，７Ｂを図５左図のように貼り、その上にポリビニルアルコール／ジメチルスルホキシドゲル８をのせた。アルミニウム箔７Ａ，７Ｂの間隔は２ｍｍとし、１０００ボルトを印加すると、図５右図のようにゲル８は正極の方へ移動した。

【００３０】

【発明の効果】以上説明したとおり、本発明の第１番目の電荷注入－溶媒牽引による駆動法は、非イオン性の誘電性溶媒または溶液に電場を印加して電荷を注入し、溶

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媒間、溶質間または溶媒・溶質間の相互作用に起因する溶媒流を誘起させることにより、実用レベルの駆動性を持つ、空気中での高速・大変形・大出力が可能な柔軟駆動方法を提供できる。

【００３１】また本発明の第２番目の電荷注入－溶媒牽引による駆動法は、ゲル前駆体に前記誘電性溶媒または溶液を染み込ませて膨潤させてゲル材料を形成し、前記ゲル材料の両面に薄膜状の電極を設け、前記ゲル材料に電場を印加することにより生じる変形を用いたことにより、同様に実用レベルの駆動性を持つ、空気中での高速・大変形・大出力が可能な柔軟駆動方法を提供できる。

【００３２】また本発明の駆動装置によれば、前記第１～２番目の駆動方法を用いることにより、実用レベルの駆動性を持つ、空気中での高速・大変形・大出力が可能な柔軟駆動装置を提供できる。

【図面の簡単な説明】

【図１】本発明の実施例２の駆動方法を説明する概略図。

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【図２】本発明の実施例３の駆動方法を説明する概略図。

【図３】本発明の実施例４の駆動方法を説明する概略図。

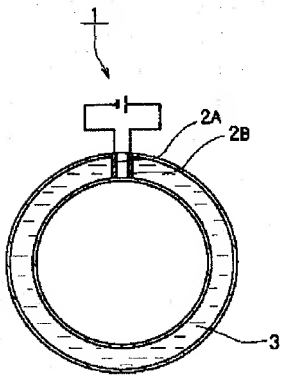
【図４】本発明の実施例５の駆動方法を説明する概略図。

【図５】本発明の実施例６の駆動方法を説明する概略図。

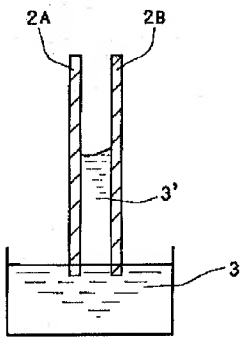
【符号の説明】

１　駆動装置
２Ａ，２Ｂ　電極（櫛型電極またはアルミニウム電極）
３，３´　ジメチルスルホキシド
４，４´　ポリビニルアルコール
５Ａ，５Ｂ　金箔電極
６　ポリビニルアルコール／ジメチルスルホキシドゲル
７Ａ，７Ｂ　アルミニウム箔
８　ポリビニルアルコール／ジメチルスルホキシドゲル

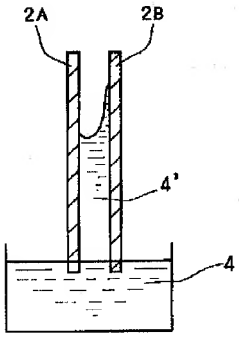
【図１】



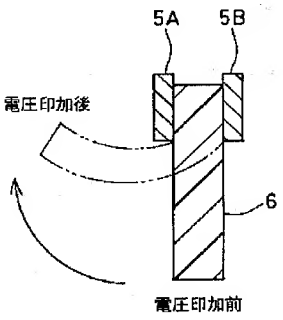
【図２】



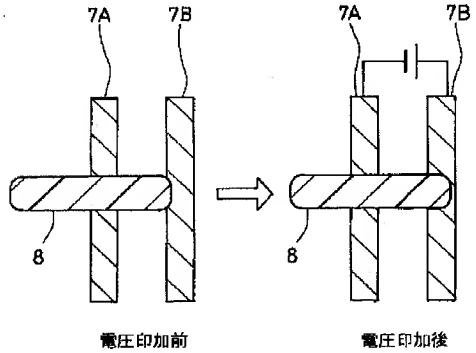
【図３】



【図４】



【図５】



CLIPPEDIMAGE= JP02000253682A
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TITLE: DRIVE METHOD BY CHARGE INJECTION-SOLVENT TRACTION AND DRIVE UNIT USING
THE SAME

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INVENTOR-INFORMATION:

NAME	COUNTRY
HIRAI, TOSHIHIRO	N/A
WATANABE, SHINJI	N/A

ASSIGNEE-INFORMATION:

NAME	COUNTRY
HIRAI TOSHIHIRO	N/A

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ABSTRACT:
PROBLEM TO BE SOLVED: To provide a flexible drive method which has drivability
on utility level and is capable of high speed, large transformation, and large
output in air, by applying an electric field to a dielectric solvent or
solution of nonionicity and injecting charge, and inducing a solvent stream
caused by the mutual action between solvents, between solutes, or between the
solvent and the solute.

SOLUTION: Polyvinyl alcohol/dimethyl sulfoxide gel 6 is cut into 5 mm in width,
7 mm in length, and 1.8 mm in thickness, and its is set sideway, and metallic
foil electrodes 5A and 5B are stuck to both sides of the gel. When 1000 V is
applied between the metallic foils on both sides of the gel, it bends, and this

angle of bend is 90

CLAIMS

[Claim]
[Claim 1] The driving method by the charge injection-solvent towage characterized by carrying out the induction of the solvent style which originates in the interaction between solvents, between solutes, or between a solvent and a solute by impressing the electric field to the dielectric solvent or solution of non-ionicity, and pouring in a charge.
[Claim 2] The driving method by charge injection-solvent towage given in the claim 1 which pours in a charge using a tandem-type electrode as a means.
[Claim 3] The driving method by charge injection-solvent towage given in the claim 1 which carries out the induction of the pressure occurrence to a solvent by pouring in a charge.
[Claim 4] The driving method by the charge injection-solvent towage which controls oil-level inclination using the pressure differential generated by impressing the electric field to the aforementioned dielectric solvent or a solution.
[Claim 5] The driving method using the deformation produced by a gel precursor infiltrating the aforementioned dielectric solvent or a solution, making it swell, forming a gel material, preparing a thin film-like electrode in both sides of the aforementioned gel material, and impressing the electric field to the aforementioned gel material.
[Claim 6] The driving method using crawling movement which the gel material swollen with the aforementioned dielectric solvent or the solution is contacted to the electrode arranged on monotonous, and is produced.
[Claim 7] The driving gear which makes the method of driving a publication a driving source at either of the claims 1-6.

[Translation done.]

DETAILED DESCRIPTION

[Detailed description]
[0001]
[The technical field to which invention belongs] This invention relates to the driving method by the electric field and the related material technique of the gel material swollen with the dielectric solvent or solution of non-ionicity. It is related with the driving gear using the high speed of the macromolecule gel by the "charge injection-solvent extension", and the method drive] for using type very much and this still in detail.
[0002]
[Prior art] This invention persons are doing research and development in the drive material and the method [drive] for having used various polymeric materials. The driving method using impression of the electric field is also included in it. Generally the driving method by the electric field of gel is excellent in deformation and responsibility also in the conventional method.
[0003] However, the polyelectrolyte gel of ionicity is the center and there are very few research and developments about the macromolecule gel of non-ionicity including this invention persons.
[0004] About the electric-field drive of a non-[dielectric] ionic gel, it is proud of the speed of response which was extremely excellent only in that there is this invention persons' proposal, and the amount of displacement (patent official report of No. 2698716).
[0005] The drive to which the variation rate of a there is strongly restricted by the metal plate, and deformation of gel limited it only to asymmetry of the orientation of the electric field with it is considered.
[0006] However, a drive like the mollusk which employed efficiently the property of the gel which is the flexible field is expected, and supposing it is possible, it is the driving method which used the property of gel most effectively.
[0007] Since the conventional polyelectrolyte gel was limited to a drive in underwater or the high water status, use in air etc. had the problem that it could not do, and also contained [except / that a drive speed was slow] the problem of the irreversible degradation for mediation of electrochemical processes, such as electrolysis, not being further avoided in a drive process.
[0008]
[Object of the Invention] In such a background, this invention is the charge and a solvent (or although it is a solution, hereafter here) formed by the diffusion process of the charge poured into the driving method with completely new "charge injection" (injection of the charge from an electrode). It aims at offering the high speed in the inside of air in which an interaction while writing it as a solvent proposes the transport system and the pressure generating method for having used the "solvent towage" which carries out an induction, improves the conventional problem, and has the drive nature of practical use level, the materials-design pointer of a flexible drive material in which type and a large output are very possible, and the driving method.
[0009]
[The means for solving a technical problem] In order to attain the aforementioned purpose, the driving method by the 1st charge injection-solvent towage of this invention is characterized by carrying out the induction of the solvent style resulting from the interaction between solvents, between solutes, or between a solvent and a solute by impressing the electric field to the dielectric solvent or solution of non-ionicity, and pouring in a charge.
[0010] In the aforementioned technique, a tandem-type electrode can be used as a means to pour in a charge.
[0011] Moreover, in the aforementioned technique, it is desirable to carry out the induction of the pressure occurrence to a solvent by pouring in a charge.
[0012] Moreover, in the aforementioned technique, it is desirable to control oil-level inclination using the pressure differential generated by impressing the electric field to a dielectric solvent or a solution.
[0013] Next, as for the driving method by the 2nd charge injection-solvent towage of this invention, a gel precursor infiltrates the aforementioned dielectric solvent or a solution, it is made to swell, a gel material is formed, a thin film-like electrode is prepared in both sides of the aforementioned gel material, and it is characterized by using the deformation produced by impressing the electric field to the aforementioned gel material.
[0014] In the aforementioned technique, crawling movement which the gel material swollen with the dielectric solvent or the solution is contacted to the electrode arranged on monotonous, and is produced can also be used.
[0015] Next, it is characterized by the driving gear of this invention making a driving source the method of driving the publication to either of the claims 1-6.

[0016]
[Gestalt of implementation of invention] The following technical means are provided in this invention. First, if the electric field are impressed to a dielectric solvent and a unipolar charge is poured in, flowing which went to the counter electrode as a collector in the type set forth from the electrode (decided by the solvent etc.) used as an emitter will occur. In order that this injection charge may lead a solvent and may carry out the induction of the flowing of a solvent, it can produce the pump which used the electrode of Kushigata. Although this pump function is a known fact, it is adding a polymer to this, the space charge distribution inside a liquid changes notably, and, as a result, the especially extremely unsymmetrical pressure distribution which should be surprised occur. That is, a pressure gradient occurs.
[0017] Since the gel of non-ionicity swollen by this solvent has the effect which makes the above-mentioned pressure distribution still unsymmetrical, it can carry out the induction of the very effective flexion deformity. By the solution system, the induction of the deformation which cannot be attained can be carried out by the electric field.
[0018] For example, this gel is produced in the shape of a layer, and the induction of the big flexion deformity can be carried out by preparing an electrode in both sides at high speed. Here, a required thing is equipping a gel front face with an electrode, and, for the reason, used the gold foil. Since this electrode is a thin film, it does not block deformation of gel.
[0019] Even if it does not give an electrode to the gel itself, the induction of the crawling movement can be carried out by placing gel on an electrode. Here, it is required to produce the array of an electrode on monotonous. Gel is placed more than this dry area, and the crawling accompanied by very big deformation is seen by impressing the electric field. A speed is very quick also here.
[0020]
[Example] Hereafter, this invention is explained still concretely using this example.
[0021] (Example 1) A flow occurred in the solvent by using the electrode of the pectinate for the dimethyl sulfoxide of a commercial best, and impressing the electric field. The electrode plate of the pectinate is a product made from aluminum in five the ctenidium spacing of 1mm, 1mm of the sizes of a ctenidium, and the number of ctenidiums. Couple readiness of this electrode was carried out, and the direct-current electric field were impressed at intervals of [of 2mm] the electrode plate. Drift velocity increased in connection with the increase in applied voltage. The 14mm [/s] rate of flow can be acquired by 1kV. This value becomes so large that a voltage is so high that a dielectric constant is large. It was observed about almost all solvents.
[0022] (Example 2) The driving gear 1 of drawing 1 puts dimethyl sulfoxide 3 into the container which has annular passage, and attaches two more tandem-type electrode 2A and 2B. In this case, in order to make flowing of dimethyl sulfoxide legible, the particle of polystyrene was distributed in dimethyl sulfoxide. When the voltage of 1000v was impressed between two Kushigata electrodes, dimethyl sulfoxide flowed along annular passage.
[0023] (Example 3) Although the solvent inserted into inter-electrode [which is put on the status that it stood perpendicularly] is drawn in inter-electrode by impression of the electric field, the pressure occurrence using the phenomenon which asymmetry remarkable in the gas-liquid interface in that case generates, and its control are performed. First, it carried out to oppose the width of face of 8mm, aluminum plate electrode 2A with a length of 5cm of two sheets, and 2B, stood, and soaked in the oil level of the dimethyl sulfoxide 3 filled with the soffit by the laboratory dish. In this case, aluminum plate 2A of two sheets and the spacing of 2B were set to 1.5mm. although between the aluminum plates of two sheets had been sucked up by dimethyl sulfoxide 3 like 3' when the voltage of 1000v was impressed between aluminum plate 2A of two sheets, and 2B -- an oil level -- right and left -- it became unsymmetrical type (refer to drawing 2)
[0024] (Example 4) the sucked-up oil level which is shown in 4' when what melted the amount percent of polyvinyl alcohol 4 (Kuraray Co., Ltd. make, Kralay 117, molecular weight =7.5x104) duplexs in dimethyl sulfoxide is used instead of dimethyl sulfoxide, and also a voltage is impressed completely like an example 3 -- right and left -- it became unsymmetrical type This asymmetric degree was much more remarkable than the case of an example 2 (refer to drawing 3).
[0025] (Example 5) The method [drive] for using a remarkable incurvation phenomenon with the speed of response of 10 ms order which occurs by impressing the direct-current electric field to the non-ionic gel which was swollen by the dielectric solvent, and which has an electrode to both sides, and the example of a drive material are explained below.
[0026] The aqueous solution which contains polyvinyl alcohol 10% of the weight, and the dimethyl sulfoxide solution which contains polyvinyl alcohol 10% of the weight were mixed at a rate of the weight ratios 7/3. At -20 degrees C, it cooled for 23 hours and the temperature up of the mixed solution was carried out to the room temperature after that for 1 hour. This cooling and the polyvinyl alcohol gel which repeated the cycle of a temperature up 4 times and carried out physical bridge formation were obtained. Next, this gel was dipped at 30 degrees C into the diluted hydrochloric acid for 80 minutes, after immersing in the glutaraldehyde aqueous solution for two days at 3 degrees C. The gel chemistry bridge formation was carried out [gel] by this was obtained. This gel was soaked into dimethyl sulfoxide and the solvent in gel was replaced by dimethyl sulfoxide.
[0027] The polyvinyl alcohol / dimethyl sulfoxide gel 6 obtained in the above procedure were cut in the width of face of 5mm, the length of 7mm, and thickness of 1.8mm, and it set sideways. The gold-foil electrodes 5A and 5B were stuck on both sides of gel. It was crooked when 1000v was impressed between the gold foil on both sides of gel (refer to drawing 4). This angle of bend was 90 degrees, and the time which this deformation took was 60 mses.
[0028] (Example 6) The above-mentioned gel which does not have an electrode is placed on a plate-like electrode array, and the method [drive] for using remarkable crawling movement produced by impressing the direct-current electric field and the example of a drive material are explained below.
[0029] On the glass plate, aluminum foils 7A and 7B were stuck, as shown in [in the left figure of drawing 5], and polyvinyl

alcohol / dimethyl sulfoxide gel 8 was carried on it. When the spacing of aluminum foils 7A and 7B was set to 2mm and 1000v was impressed, as shown in [in the right figure of drawing 5], gel 8 was moved to the direction of a positive electrode.

[0030]
[Effect of the invention] The driving method by the 1st charge injection-solvent towage of this invention impresses the electric field to the dielectric solvent or solution of non-ionicity, pours in a charge, and can offer the high speed and the flexible drive technique in which the type and the large output are very possible in the inside of air with the drive nature of practical use level by carrying out the induction of the solvent style resulting from the interaction between solvents, between solutes, or between a solvent and a solute as explained above.
[0031] Moreover, the driving method by the 2nd charge injection-solvent towage of this invention By having used the deformation produced by a gel precursor infiltrating the aforementioned dielectric solvent or a solution, making it swell, forming a gel material, preparing a thin film-like electrode in both sides of the aforementioned gel material, and impressing the electric field to the aforementioned gel material The high speed and the flexible drive technique in which the type and the large output are very possible in the inside of air which have the drive nature of practical use level similarly can be offered.
[0032] Moreover, according to the driving gear of this invention, the high speed and the flexible driving gear in which the type and the large output are very possible in the inside of air with the drive nature of practical use level can be offered by using the 1-2nd aforementioned drive technique.

[Translation done.]

TECHNICAL FIELD

[The technical field to which invention belongs] This invention relates to the driving method by the electric field and the related material technique of the gel material swollen with the dielectric solvent or solution of non-ionicity. It is related with the driving gear using the high speed of the macromolecule gel by the "charge injection-solvent extension", and the method drive] for using type very much and this still in detail.

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PRIOR ART

[Prior art] This invention persons are doing research and development in the drive material and the method [drive] for having used various polymeric materials. The driving method using impression of the electric field is also included in it. Generally the driving method by the electric field of gel is excellent in deformation and responsibility also in the conventional method.
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[Translation done.]

EFFECT OF THE INVENTION

[Effect of the invention] The driving method by the 1st charge injection-solvent towage of this invention impresses the electric field to the dielectric solvent or solution of non-ionicity, pours in a charge, and can offer the high speed and the flexible drive technique in which the type and the large output are very possible in the inside of air with the drive nature of practical use level by carrying out the induction of the solvent style resulting from the interaction between solvents, between solutes, or between a solvent and a solute as explained above.
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[Translation done.]

DESCRIPTION OF DRAWINGS

[An easy explanation of a drawing]
[Drawing 1] The schematic diagram explaining the drive technique of the example 2 of this invention.
[Drawing 2] The schematic diagram explaining the drive technique of the example 3 of this invention.
[Drawing 3] The schematic diagram explaining the drive technique of the example 4 of this invention.
[Drawing 4] The schematic diagram explaining the drive technique of the example 5 of this invention.
[Drawing 5] The schematic diagram explaining the drive technique of the example 6 of this invention.
[An explanation of a sign]
1 Driving Gear
2A, 2B Electrode (a tandem-type electrode or aluminum electrode)
3, 3' Dimethyl sulfoxide
4, 4' Polyvinyl alcohol
5A, 5B Gold-foil electrode
6 Polyvinyl Alcohol / Dimethyl Sulfoxide Gel
7A, 7B Aluminum foil
8 Polyvinyl Alcohol / Dimethyl Sulfoxide Gel

[Translation done.]

EXAMPLE

[Example] Hereafter, this invention is explained still concretely using this example.
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